Medial sural artery perforator (MSAP) flap: historical development, clinical indications, complications and current management in reconstructive surgery

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Background: The medial sural artery perforator (MSAP) flap has emerged as a versatile and reliable option for soft tissue reconstruction requiring thin, pliable coverage and minimal donor-site morbidity. Since its first clinical description in the early twenty-first century, its use has expanded to head and neck, extremity, and complex three-dimensional reconstructions. To review the historical development, anatomical basis, clinical indications, surgical technique, reported complications, and current management strategies of the MSAP flap in reconstructive surgery. A narrative review of the literature was performed using PubMed, Scopus, and Google Scholar databases, including anatomical studies, clinical series, systematic reviews, and recent publications between 2001 and 2025 related to the MSAP flap. Flap characteristics, indications, outcomes, and complication rates were analyzed and synthesized. The MSAP flap is based on musculocutaneous perforators arising from the medial sural artery and provides a long, reliable pedicle with suitable vessel caliber for microvascular anastomosis. Recent studies demonstrate its wide application in head and neck reconstruction as an alternative to the radial forearm free flap, as well as in coverage of lower-extremity and periarticular defects. Overall complication rates range between ten and fifteen percent, with venous congestion and partial flap necrosis being the most frequently reported adverse events. Advances in preoperative perforator mapping, anatomical algorithms, and refined microsurgical techniques have significantly improved flap survival and reduced donor-site morbidity. The MSAP flap represents a valuable reconstructive resource. Detailed knowledge of its vascular anatomy, careful perforator selection, and early recognition and management of complications are essential to maximize flap survival and achieve optimal functional and aesthetic outcomes.

Keywords: MSAP flap, Medial sural artery flap, Lower limb reconstruction.

The development of perforator flaps has revolutionized reconstructive surgery by allowing selective transfer of skin and subcutaneous tissue while preserving underlying muscles and major vascular trunks. This evolution has resulted in a significant reduction in donor-site morbidity without compromising flap reliability. Among these flaps, the medial sural artery perforator (MSAP) flap has gained increasing acceptance due to its thin profile, pliability, long vascular pedicle, and favorable donor-site characteristics.

Originally introduced as an alternative to classical fasciocutaneous and musculocutaneous flaps, the MSAP flap has progressively expanded its indications, particularly in head and neck reconstruction and coverage of complex extremity defects. This review summarizes the historical background, anatomical foundations, clinical indications, complications, and contemporary management strategies of the MSAP flap, emphasizing its role in modern reconstructive surgery.

Methods

A narrative review of the English-language literature was conducted using PubMed, Scopus, and Google Scholar databases. Search terms included “medial sural artery perforator flap”, “MSAP flap”, “perforator flaps”, and “reconstructive surgery”. Anatomical studies, original clinical series, comparative studies, systematic reviews, and recent publications from 2001 to 2025 were included. Articles focusing on surgical anatomy, indications, outcomes, and complications were analyzed and integrated into a comprehensive synthesis.

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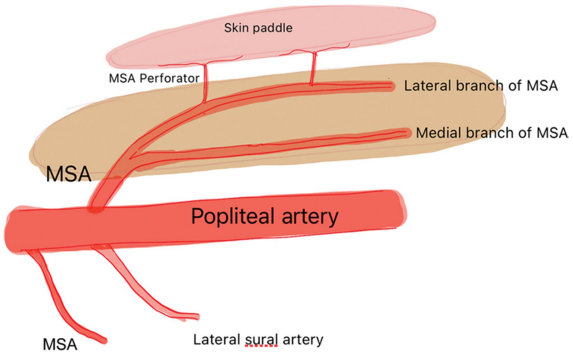

Figure 1. Vascular anatomy of the medial sural artery perforator flap. Schematic representation of the medial sural artery arising from the popliteal artery and giving off musculocutaneous perforators to the posteromedial calf skin. Adapted from Titus HM et al., Indian J Plast Surg. 2024.

Results

HISTORY AND ANATOMICAL DEVELOPMENT

The anatomical foundations of the MSAP flap derive from the classical angiosome concept introduced by Taylor and Palmer, who described the cutaneous vascular territories supplied by source arteries (Figure 1). Subsequent studies of the posterior calf region demonstrated that the medial sural artery, a branch of the popliteal artery, provides consistent musculocutaneous perforators traversing the medial head of the gastrocnemius muscle toward the overlying fascia and skin.

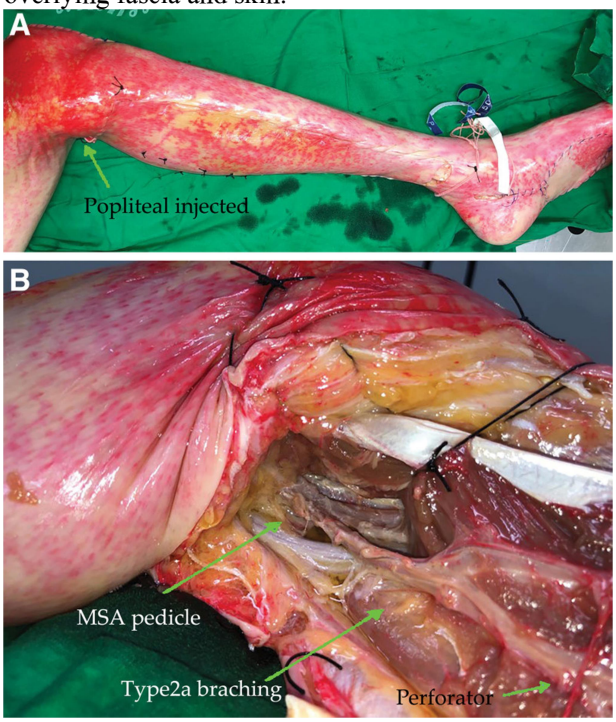

Figure 2. Anatomical dissection showing medial sural artery pedicle and perforator branching patterns. Adapted from Akaranuchat N et al., Plast Reconstr Surg Glob Open. 2024.

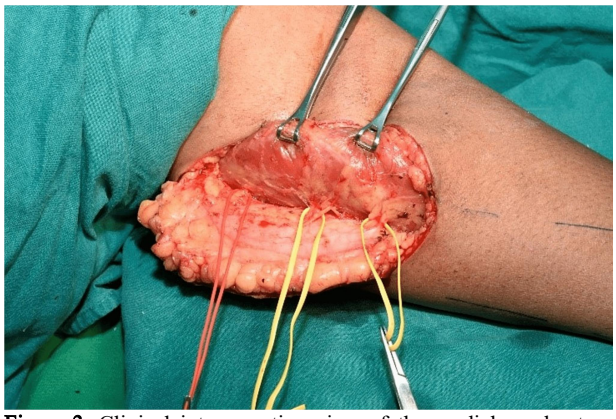

Figure 3. Clinical intraoperative view of the medial sural artery perforator flap during harvest, demonstrating identification of the dominant perforator and vascular pedicle. Adapted from Mishra S et al., Cureus. 2022.

The first clinical application of the MSAP flap was reported by Cavadas and colleagues in 2001, who described it as a thin fasciocutaneous free flap with a long pedicle and minimal functional deficit at the donor site [1]. Early reports highlighted its potential as an alternative to the radial forearm free flap, especially when donor-site aesthetics were a concern. Over the following two decades, multiple anatomical and clinical studies refined the description of perforator location, number, and caliber, establishing the MSAP flap as a reliable option in perforator-based reconstruction.

Recent cadaveric and imaging studies have emphasized the anatomical variability of perforators [5,6] (Figure 2), reporting one to three dominant perforators in most individuals and proposing preoperative mapping algorithms to facilitate intraoperative decision-making. The introduction of chimeric and multi-component designs further expanded the versatility of the MSAP flap in complex reconstructions.

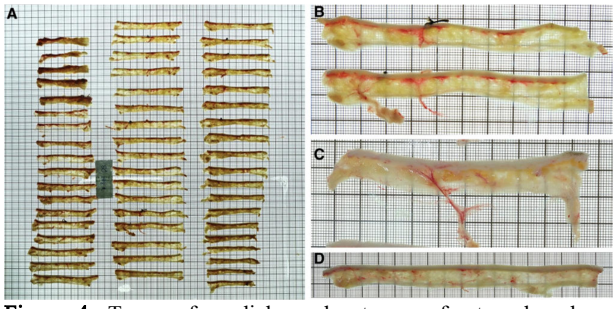

Figure 4. Types of medial sural artery perforators based on branching pattern after fascial penetration. Adapted from Akaranuchat N et al., Plast Reconstr Surg Glob Open. 2024.

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Figure 5. Preoperative skin marking and design of the medial sural artery perforator flap on the posteromedial aspect of the calf.

INDICATIONS

Head and neck reconstruction remains the most frequent indication for the MSAP flap [2,3] (Figure 4). Its thin and pliable characteristics make it particularly suitable for reconstruction of intraoral defects, tongue, floor of mouth, and oropharyngeal lining. Several recent comparative studies have shown functional outcomes comparable to the radial forearm free flap, with superior donor-site aesthetics and reduced morbidity.

In lower-extremity reconstruction, the MSAP flap has been used successfully for coverage of traumatic, oncologic, and chronic defects of the leg, ankle, and foot. Its long pedicle and reliable perforators allow both free and pedicled applications, including propeller-type flaps for periarticular knee and proximal leg defects. Based on current evidence, the MSAP flap should be considered a first-line option in selected patients requiring thin and pliable soft-tissue reconstruction.

Additional indications include reconstruction of small- to medium-sized soft-tissue defects of the upper extremity and selected pharyngoesophageal reconstructions, where thin mucosal lining and flexibility are required. The flap is particularly advantageous when muscle preservation and minimal bulk are essential to restore function and contour.

COMPLICATIONS AND MANAGEMENT

Despite high overall success rates, complications associated with the MSAP flap have been consistently reported (Figure 3). Venous congestion represents the most frequent early complication [2,7] and is often related to insufficient venous outflow or torsion of the pedicle. Prompt recognition and early surgical exploration remain critical for flap salvage.

Partial or total flap necrosis has been described in up to ten to fifteen percent of cases, particularly in large flaps or in the presence of unfavorable perforator anatomy. Donor-site complications include wound dehiscence, delayed healing, and the need for split-thickness skin grafting when primary closure is not feasible. Rarely, injury to the medial gastrocnemius muscle may result in localized weakness or contour deformity.

Current management strategies emphasize meticulous preoperative perforator mapping using handheld Doppler or computed tomographic angiography, careful intramuscular dissection, and consideration of additional venous anastomoses in large flaps (Figure 5). Standardized postoperative monitoring protocols and early re-exploration algorithms have significantly improved salvage rates and overall outcomes.

Discussion

The MSAP flap has evolved into a dependable reconstructive option combining thin tissue quality, long pedicle length, and limited donor-site morbidity. Although technically demanding, its advantages make it an excellent alternative to traditional workhorse flaps in selected patients. Ongoing anatomical research and refinement of microsurgical techniques continue to expand its clinical applications.

Conclusion

The medial sural artery perforator flap is a valuable and versatile tool in reconstructive surgery. Proper patient selection, detailed understanding of perforator anatomy, and meticulous surgical technique are essential to minimize complications and optimize functional and aesthetic results.

Conflicts of interests

The authors declare no conflicts of interest related to this manuscript.

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